Notification of Alerts Generated by Real-Time Pharmacy Expert Systems

Ervina Resetar, AAS, Laura A. Noirot, BS, Robert Harrison, MS, Thomas C. Bailey, MD
Medical Informatics, Washington University School of Medicine
resetare@informatics.wustl.edu

INTRODUCTION

Medical Informatics at the Washington University School of Medicine developed and implemented a strategy for notifying clinical pharmacists of alerts generated in real time by previously developed pharmacy expert systems. The real-time pharmacy expert systems examine medication orders for underdosing or overdosing of medications and detect orders for potentially dangerous drug combinations at Barnes-Jewish Hospital (BJH) and Christian Hospital Northeast (CHNE) of BJC Health System, St. Louis, MO.

Methods of alert notification and the content of the information delivered were seen as key to the success of the real-time expert system deployment. It was necessary that alerts be delivered on time and with the right level of patient information so that pharmacists could act on them without first looking at the patients' charts. This paper describes our experience with alert delivery methods and formatting, a 30-day trial at BJH, and results of our subsequent deployment.

SELECTING THE RIGHT DELIVERY METHOD

Among the factors considered when making the decision about the best method for delivering the alerts were:

- Urgency of the alert
- Potential impact on the workflow of the pharmacists
- Amount of information the pharmacist needed to act on the alert
- Pharmacist mobility

The alert delivery methods considered included cell phone, voice mail, e-mail, fax, and display pager. Direct notification via cell phone was ruled out because cell phones were not in common use by the pharmacists. More importantly, there were problems with cellular coverage in several key areas in the hospital, which did not lend itself to the delivery of urgent alerts.

Voice mail, e-mail, and fax are common tools in the hospital and are similar in that they can be handled well in "batch mode." These communication methods integrate well into the workflow of the pharmacists but are not well applied in situations where mobility is needed or where immediate notification is desired.

Display pagers work well for delivering urgent messages. Most clinicians carry pagers and are familiar with their use. Many have begun to use display pagers to extend pager functionality beyond numeric messages. Disruptions to workflow are reduced with display pagers because enough information can be included in the message to allow the recipient to prioritize her or his response without stopping to make a phone call or look at a chart. Paging service coverage is still an issue because some areas of the hospital are shielded by electromagnetic equipment such as magnetic resonance imaging machines. This shortcoming can be partially overcome through use of a paging service that stores and delivers pages when the pager comes back into range.

FORMATTING DELIVERED INFORMATION

With the addition of display pagers for alerts, we needed to redesign a well-established format for printed and faxed alerts that contained thousands of characters. The goal was to reduce this information to the minimum needed to inform the pharmacist of the problem and recommend corrective action. It was also important to maintain readability and ensure clarity of the display pager text.

The essential information needed by the pharmacist to verify the legitimacy of an alert included:

- Patient identification and demographics—medical record number and patient name, age, height, weight, and ideal body weight
- Medication order information—order number, medication name, amount, route, and frequency
- New recommended medication dose—amount, route, and frequency
- Information for contraindicated medication orders
- Relevant lab results—three most recent serum creatinine and calculated creatinine clearance values

Once the essential data were identified, a layout of a pager display with the required information was designed.

TRIAL RESULTS

To test notification method acceptance and display content, we conducted a trial in July 1999[1]. The recipients of the alerts were 11 highly motivated clinical pharmacists. Over the period of the trial, 147 alerts were generated, comprising 30 operational days. To assess notification preferences, each alert was assessed individually for pharmacist agreement with the alert and for appropriate notification timing—too early or too late. We received 114 responses to this question. The majority (74 percent) felt that the timing was appropriate. In addition, the pharmacists were directly surveyed regarding their preferences for alert notification modality. When given the option of choosing a single alerting modality, 50 percent of the trial pharmacists preferred alpha pagers, with smaller percentages preferring fax or e-mail notification. However, it was clear from this alpha trial and from subsequent user feedback that not all alerts were regarded with equal weight and that a method for prioritization was needed, with higher priority alerts delivered by alpha pager and lower priority alerts delivered by fax or e-mail. Furthermore, users expressed the desire to batch lower priority alerts to decrease workflow disruption. Although the pharmacists desired to be paged with high-priority alerts and agreed that the format of the alpha page contained all the pertinent clinical information they needed to act on it, they desired a paper copy of the alert as a worksheet in addition to the alpha page. CHNE pharmacists expressed preference for alerts delivered by fax regardless of priority level.

DEPLOYMENT

In September 1999 we deployed an enhanced notification application, which utilizes alpha pager, fax, and Web modalities. High-priority alerts are sent by alpha pager and are also faxed to the pharmacist responsible for the patient. Reminder alerts and an escalation feature help ensure that these alerts are attended to promptly. As shown in Figure 1, a relatively large number of lower priority alerts are generated in real time and faxed to the responsible pharmacists, and a smaller number of higher priority alerts are sent via pagers with an accompanying fax.

Lower priority alerts are sent by fax to the responsible pharmacists three times a day, with times chosen to correspond to pharmacy order volume and integrate with pharmacist workflow. Alert information can also be viewed by means of a Web interface, which also can be used for alert outcome feedback. Faxed alert forms are also used for alert outcome feedback. At BJH, the pharmacists almost exclusively use these faxed forms to provide this feedback, whereas at CHNE, the Web interface is exclusively used for this purpose. This is a result of user preference and the fact that the responsibility for addressing clinical alert outcomes is distributed over many users at BJH; at CHNE, there is a single designated pharmacist to provide this feedback. Through an iterative process, we have deployed a useful and well-accepted means for notifying pharmacists of prescription error alerts using multiple notification

modalities that are based on user preference and alert priority.

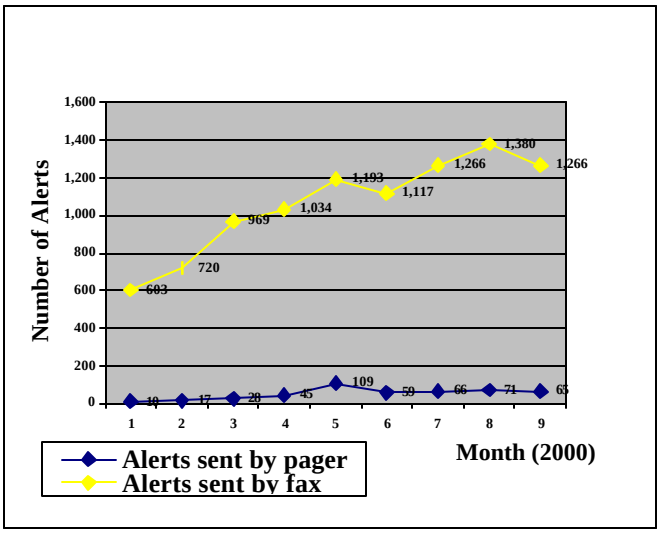

Figure 1. Number of High- Versus Low-Priority Alerts

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REFERENCE

1. Miller JE, Reichley RM, McNamee LA, Steib SA, Bailey TC. Notification of real-time clinical alerts generated by pharmacy expert systems. *Proc AMIA* 1999;325-329.